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*THE ACTION OF RADIUM, ROENTGEN RAYS AND ULTRA-VIOLET LIGHT ON MINERALS AND GEMS.**

THE purpose of this paper is to recount the results of our investigations as to the conduct of the gems and gem-material of the Tiffany-Morgan collection under the influence of Roentgen rays, ultra-violet light and emanations of radium preparations. By the courtesy of the American Museum of Natural History, we were permitted to make a careful study of the action of these agents upon the minerals in the handsome Morgan-Tiffany and Morgan-Bement collections. These undoubtedly are the most complete collections of authenticated minerals and gems on exhibition in the United States. The fluorescence and phosphorescence resulting from the action of ultra-violet light upon about 13,000 verified minerals were carefully observed. In addition to the above, we had an opportunity to submit selected stones from about 15,000 British Guiana diamonds and two particularly handsome diamonds (one being a tiffanyite) and several carbonadoes to these influences, the products of the most modern scientific investigations.

As there is no uniform meaning accepted for the term 'fluorescence' and 'phosphorescence,' in the outset we wish to emphasize our interpretation. Jackson would have

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them meaning the same. Perhaps they are in reality the same phenomena; but in this paper by fluorescence we mean a luminosity, more usually evidenced by a play of color, lasting only during the direct influence of the exciting agent. By phosphorescence, we mean the emission or propagation of ethereal stresses, which affect the optical centers, producing light, white or colored, which persists after the removal of the cause. Substances may, therefore, be both fluorescent and phosphorescent.

The radium preparations of the highest activity used in these investigations became the property of the American Museum of Natural History through the liberality of Mr. Edward D. Adams, a member of the Board of Administrators of the Museum and of the New York Academy of Sciences. His gift of the necessary funds was applied to the purchase of one portion of radium bromide of 300,000 activity and another of 1,800,000; uranium being taken as the standard at 1. The preparations were obtained from the Société Centrale des Produits Chimiques at Paris. Unfortunately, although the order was authorized and material assured, it has been impossible to obtain the bromide of the highest strength in time for presentation at this meeting. The results here announced have to do with the radium of 300,000 and of 7,000 activity (chloride) and 240 (chloride) and of 100 radium barium carbonate. The compounds of lower activity were purchased by the authors.

The intense penetrative powers of radium preparations have been previously noted by numerous investigators—as the Curies, Strutt, Rutherford and others—mentioned later. The bibliography is so extensive that no effort is made to give all the references in this abbreviated paper. A remarkable illustration, almost startling, of its penetration was demonstrated with the following experiments: Radium bromide of 300,000 activity was placed in a sealed glass tube contained in a rubber thermometer-holder, the top of which was tightly screwed down, and the whole placed in a water-tight tinned-iron box; over the box were placed, first, a heavy silver tureen 1.5 mm. thick, then four copper plates, such as are used for engraving, and finally a heavy graduated measuring-glass 10 cm. in diameter filled with water to a depth of 15 cm. A diamond was then suspended in the water and became fluorescent immediately. Whenever the tube with radium was withdrawn a distance of more than one meter, the fluorescence ceased, but was resumed on replacing the radium under the tureen. This experiment showed that the influence of the radium was exerted successively through glass, rubber, silver 1.5 mm. thick, four copper plates, glass 0.5 cm. thick, and finally 8 cm. of water.

With all these wonderful properties of radio-activity, there is yet a certain amount of discussion at the present time between the German and the French investigators. Some of the former say that radium of 300,000 activity seems to them improbable; and that no scientific man should take this expression seriously. They believe that if metallic radium is ever obtained its activity will not exceed 100,000. This view is reiterated by others, who also state that these activities are only surmised, that they are not accurately determined, and can not be sustained by definite measurements. Madame Curie unhesitatingly speaks of the difficulties attending accurate measurements of such high radio-activity.

Incidentally it may be well at this point to call attention to the complex nature of these radiations. While a number of researches from such physicists as Becquerel, Professor and Madame Curie, Meyer and von Schweidler, Giesel, Elster and Geitel, Villard and Rutherford have proved the

intricacies of the radiations of these radio-active bodies, without doubt the last named has given us the clearest conception of their nature. Professor Rutherford, as a result of his investigations, resolved them into three classes, which for convenience are designated α, β and γ rays. They possess the following characteristics:

I. "The α-rays are very slightly penetrating, and appear to constitute the principal part of the radiation. These rays are characterized by the laws by which they are absorbed by matter. The magnetic field acts very slightly upon them, and they were formerly thought to be quite unaffected by the action of this field. However, in a strong magnetic field, the α-rays are slightly deflected; the deflection is caused in the same manner as with cathode rays, but the direction of the deflection is reversed; it is the same as for the canal rays of the Crookes tubes.

II. "The β-rays are less absorbable as a whole than the preceding ones. They are deflected by a magnetic field in the same manner and direction as cathode rays.

III. "The γ-rays are penetrating rays, unaffected by the magnetic field, and comparable to Roentgen rays."

From the experiments given above it appears that the γ-rays alone suffice to intensify the fluorescent properties of the bluish-white tiffanyite diamond.

While it is quite beyond the scope of this paper either to contribute much that is novel as to the real nature of radium or even to speculate thereon, some reference to a few of the numerous recent researches is essential for a clear understanding of a part of that which follows.

Professors Rutherford, Soddy and Dewar, and Sirs William Ramsay, William Crookes and William Huggins, with Lady Huggins, have obtained helium from radium preparations which are luminous in the dark. Professors Soddy and Ramsay have obtained helium from thorium oxide, which is also radio-active, as first observed independently by G. C. Schmidt and Madame Curie. Indications are that the luminosity of radium has some relation with this stellar and telluric element and it has been intimated that its propulsion constitutes the α-rays. Professor C. Vernon Boys has even suggested that the tails of comets may be accounted for, perhaps, by the evolving of this form of radio-activity. W. E. Wilson and Joly have made the 'suggestion that the presence of radium in the sun might enter as an important factor in contributing to solar radiations.'

Radium preparations are to be had on the market from French and German sources which are *non-luminous*. We are not informed as to efforts to secure helium from this variety. We do know, however, that certain minerals, as willemite and kunzite, become strongly fluorescent and phosphorescent under the influence of luminous radium compounds. Further, as the result of experiment of one of us, we know that pulverized willemite immediately glows in the dark when in contact with non-luminous radium barium carbonate of 100 activity, as do also certain diamonds, and the minerals mentioned above.

Thorium dioxide does not become luminous in contact with the radium preparations we have been able to obtain, although Elster and Geitel state that a thorium oxide screen shows scintillating fluorescence even after positive electrification, similar to the zinc blende.

Why certain rays either alone or through their influence upon the surrounding media present the order of magnitude of visible light waves, we shall not undertake to say. It is quite evident, however, that particular substances, like the diamond, willemite, kunzite, etc., possess the power of 'stepping up or down,' as it were, the ethereal stresses propagated by the radium, so that visible

rays result, or the bombardment of electronic emanations produces such an effect. The luminosity can not be attributed solely to the α-rays, or helium, as thorium oxide does not respond (at least visibly to the eye unaided by magnifying lenses), unless it so happens that the helium exists in one radio-active body in a different form from that in the other. Further, we have tested a number of helium-bearing minerals and none responded to the strong radium bromide. It appears that the luminosity of such substances, so variable in their construction as those mentioned above, may be accounted for in a measure by the physical explanations adverted to; yet, the striking fact that four zinc compounds of totally different composition, willemite (zinc orthosilicate), zinc sulphide, zinc oxide and kunzite (which contains a fraction of a per cent. of zinc) all respond in the most pronounced manner to radium emanations, would indicate the presence of a new element, a 'radium-foil,' as it were, or some unusual combination of known chemical integers, which synchronize with the activities of this unique body, in fact radio-active responsive bodies. One is immediately reminded of the actinium that Phipson announced in the eighties as being present in zinc white. (This is not to be confounded with Debierne's actinium, resembling titanium, announced in 1898.)

Becquerel, as is well known, first observed that certain substances, without any previous artificial excitation, emit rays which affect a photographic plate in the dark. Non-luminous radio-active bodies readily give this evidence of the presence of 'Becquerel rays.' We have made a paint, composed of zinc sulphide and radium barium carbonate in linseed oil, for making prints directly upon sensitive photographic films. The exposures varied from thirty-five minutes to an hour, some being made through glass. This would indicate the production of actinic rays and, furthermore, rays differing from those of the ultra-violet, the transmission of which are interfered with by glass.

Selected gems were mounted in paraffine blocks, held in wooden frames, obtained by pouring the hydrocarbon, after melting in a water-bath, into especially constructed boxes about 18 x 27 cm. and 1.5 cm. deep. The wooden bottoms attached to the frames by screws were readily removed. Each 'plate' was numbered by placing small hot wire nails on the paraffine. Where gems of the same species varied in color they were arranged according to the spectrum as far as practicable. Comparisons as to color effects could thus be had, but of course no comparison of penetrative effects, as the stones were of variable thickness. They were photographed in place.

These plates admitted of a careful comparative examination of the gems when subjected to the bombardment of the Roentgen rays produced by a Queen's self-regulating Crookes' tube with a twelve-inch spark coil. Many radiographs were also obtained with variable exposures, the iron markers adverted to, through their impenetrability, serving to identify the plates.

Perhaps no such complete collection has been studied in this manner, although Doelter in 1896 published a most interesting study of the conduct of some sixty-five minerals and other precious stones when subjected to the Roentgen rays. During the same year J. B. Cochrane published a very practical paper on the testing of precious stones by Roentgen rays. Without giving details, it may be said that their observations were verified, and in general, it was learned that the penetration of gem material by these rays is a matter of degree rather than kind, and sharper contrasts were obtained with certain precious stones when they were surrounded by metals, like gold or lead, than was had when they were

radiographed alone. The observations of the late Professor Ogden N. Rood on the deflection of Roentgen rays by crystal or cut faces were verified.

J. E. Burbank in 1898 published a work on mineral phosphorescence produced by X-rays. Of all the substances tried, he found 'in general minerals containing ores of the metals are non-phosphorescent' and that fluorite and calcite seemed most suitable for experimentation. J. Trowbridge states: "By them (X-rays) an electrical charge is communicated to fluorescent and phosphorescent substances. The resulting electrical energy, in being dissipated (by heat), produces the phenomenon of light" (see below). Thomas A. Edison directed the Roentgen rays upon some eighteen hundred chemical compounds, artificial and natural, seeking a fluorescent screen. Later (1900) Bary examined the conduct of a number of salts under the influence of Roentgen rays. "Those which become fluorescent belong, with the exception of uranium, to the families of the alkalies and alkaline earths. Similar results were obtained by exposure to the radiations from a radio-active metal supplied by Curie."

Robert Boyle in 1663 appears to have been the first to have made a truly scientific examination of the phosphorescence of diamonds, although the alchemist, Albertus Magnus, in the thirteenth century, said he had seen a diamond which glowed when it was put in hot water. Bernouilli remarked that when a diamond is rubbed on gold it becomes luminous 'like a burning coal excited by the bellows,' as Draper put it. 'A light, too, that cannot be extinguished by water, and yet so ethereal and pure that it can set nothing on fire' attracts the scientific imagination as much to-day as it did then.

Two hypotheses were offered in the eighteenth century in explanation of phosphorescence.

1. Léméry in 1709 maintained that phosphorescent bodies act like sponges to light, absorbing it and retaining it by so feeble a power that very trivial causes suffice for its extinction.

2. DuFay in 1735 held that it resulted from actual combustion taking place in the sulphureous parts of the glowing body. He first noted that the substance requires previous exposure to light; it glows in the dark with decreasing luminosity. DuFay also observed the effect of interposing colored glass between the phosphorescent body and the light.

In 1859 J. H. Gladstone exhibited diamonds strongly fluorescent in the sunshine. Silvanus Thomson used one of these diamonds in 1896 in a lecture on luminescence at the Royal Institution.

We are not offering a complete history of fluorescence or phosphorescence, nor explanations of these fascinating properties; but hints are given below which may serve to assist in their elucidation.

MM. Mascart and Chaumet examined a number of gems under the influence of violet light. One of us (K.), in 1889, with Mascart, and with Hallock in 1894, submitted bluish-white, opalescent diamonds (from Bagagem Mines, Brazil—tiffanyite) to electric light passing through glass of different colors.

Although, as will be mentioned, such compounds as alumina, alkaline earth sulphates and certain rare earth oxides, have been examined in vacuum tubes under the influence of electric sparks, we are not aware of any very extended examination of mineral or chemical substances when subjected to ultra-violet light produced by sparking. E. Becquerel in his 'La Lumière, ses Causes et ses Effects' states that 'the electric spark acts only by its light, but its action is more energetic than that of the sunlight by reason of its great intensity and the proximity of the source.' Wieder-

mann and G. C. Schmidt, in an article on luminescence, reached the conclusion that the *violet* light alone of the electrical discharge does not cause phosphorescence, which is 'due to peculiar discharge rays analogous to cathode rays.' M. W. Hoffman confirmed the above. J. Trowbridge reported, 'The action of the X-rays on this mineral (fluorite) was exactly similar to that of electrification,' and concluded that 'by them (X-rays) an electrical charge is communicated to fluorescent and phosphorescent substances.'

While there may be no question as to the above statements for the particular materials examined—and they are doubtless true for many other substances—yet in our observations there are some which do not admit of the sweeping conclusion that all fluorescent and phosphorescent phenomena observed in minerals subjected to rays coming from the sparking of high voltage currents with iron terminals are due to electrification.

The ultra-violet light was produced by a triple spark through quadruple iron terminals (we may so designate them) with a high voltage current. The direct current was taken from a 110-volt circuit passed through a Ruhmkorff coil with a 12-inch spark and stepped up by two Leyden jars in series. The sparker was provided with a quartz window surrounded by vulcanite and otherwise insulated to permit comfortable handling. As the number of observations to be made was very great, it was impracticable to remove each individual specimen from the exhibition cases and storage cupboards to the dark room, although this was done in many experiments. Flexible cables 200 feet long were joined to the apparatus. This was placed upon rollers and could be moved easily to the various aisles between the cases. The Piffard lamp was joined up with the apparatus by insulated wires, further protected by rubber tubing, 36 feet long. About 13,000 minerals were thus examined by night.

A large mass of original material has been gathered, of which only a few general observations and tentative conclusions are here presented.

The three most responsive minerals to all three forms of activity were found to be willemite, kunzite and certain diamonds.

In a subsequent investigation with the still more rare and novel element actinium, the particulars of which will be given at the end of this paper, these same three minerals were found to respond markedly to that substance, though with some special features.

1. It was found that willemite from Franklin, N. J., is both fluorescent and phosphorescent with the Roentgen rays, ultra-violet rays and when exposed to radium emanations. These properties were retained, although in some instances the specimens were considerably altered by decomposition. Foreign specimens of the same species were not affected at all. The willemite retained its luminescence for more than twenty-four hours after it had been exposed to radium; the latter not being then within 100 feet of it. Willemite and diamond also responded to polonium that formed a coating on a bismuth rod.

Willemite has also been noted as triboluminescent, *i. e.*, emitting light upon attrition or percussion, even when it merely strikes the side of a glass in which it is suspended in water.

2. The calcite from Franklin, N. J., showed a distinct red glow with the ultra-violet rays. This mineral, as well as the associated willemite, showed very marked peculiarities of color, the willemite green and yellow-green, the calcite a red glow. These effects were so characteristic that it required but a moment to identify the

specimens in various parts of the collection as being from Franklin, N. J.

3. The gangue of all minerals from Pajsberg and Langban, Sweden, also showed this peculiar red glow; the limestone strikingly like the calcite from Franklin, N. J.

fluoresced with radium; those tested with magnesium light phosphoresced.

5. Hydro-zincite, from Algiers, showed a remarkable fluorescence, bluish in color, different from anything in the collection.

6. Autunite and another uranium mineral, from Mitchell County, N. C.,

Radio-active Minerals. Madame Curie's Table of Ampères, Intensity 1.		Kunz-Baskerville Observations on Phosphorescence or Fluorescence with			
		Ultra-violet Light.		Roentgen Rays.	
Uranium	2'3				
Pitchblende from Johanngeorgenstadt	8 3		—		—
Pitchblende from Joachimsthal	7 0		—		—
Pitchblende from Przibram	6 5		—		—
Pitchblende from Cornwallis	1 6		—		—
Cleveite	1 4		—		—
Autunite	2 7		+		+
Sipylite		Amherst Co., Va.	—		—
	0 1	Barkevik, Nor.	—		—
	0 3	(Auerlite)			
Various thorites	0 7	Green R., N. C.	—		—
	1 3				
	1 4				
Orangite	2 0	Arendal, Nor.	—		—
Monazite	0 5	Cheyenne Co., Col.	—		—
Xenotime	0 03	Alexander Co., N. C.	—		—
Æschynite	0 7	Hitteroe, Nor.	—		+
Fergusonite (two samples)	0 4	Llano Co., Tex.	—		—
	0 1	Ytterby, Swe.	—		—
Samarskite	1 1	Berthier Co., Que.	—		—
Niobite (two samples)	0 1				
	0 3				
Tantalite	0 02				
Carnotite	6 2				
Columbite		Portland, Conn.	—		—
Monazite		Arendal, Nor.	—		—
		Zlatoust, Ural.	—		—
(171st St. and Washington Ave.)		N. Y. City.	—		—
		Amelia C. H., Va.	—		—
		Alexr. Co., N. C.	—		—
(Sand.)		Rio, Brazil.	—		—
		Tvedestrand, Nor.	—		—
Polycrase	near	Marietta, S. C.	—		—
Euxenite		Mitchell Co., N. C.	—		—

Column 1 is Madame Curie's list of rare minerals; 2 is K.-B. ultra-violet rays; 3, Roentgen rays. With one exception, neither of the latter shows any action.

4. All the minerals from Borax Lake, California—the colemanite, hanksite, glauberite, iddingsite and many others—without exception phosphoresced with ultra-violet rays. The briefest exposure caused them to glow and to retain this luminescence for a considerable time; but none of these minerals either phosphoresced or fluoresced wonderfully, while foreign specimens of the same species did not. Autunite appears to have two minerals present with it; one an orange and the other a lemon yellow; one pulverulent and the other in slight tabular crystals. The striking fluorescence obtained with ultra-violet rays was not produced

when glass, which is opaque to these rays, was interposed.

The yellow mineral labeled 'greenockite,' from Franklin, N. J., fluoresced in an identical manner, leading one to infer that this is itself a uranium mineral, or else contains the same substance that causes the autunites to fluoresce.

A comparative table is appended. It is self-explanatory and serves to illustrate the conclusions apparently inevitable, namely, the presence of something not previously recognized.

7. Hyalite (botryoidal), on a trachytic rock, from San Luis Potosi, Mexico, as colorless as the purest water, fluoresced most intensely, with a rich British green color; but these specimens did not phosphoresce. This green fluorescence could be observed when the source of the ultra-violet rays was five or six feet away. It did not persist on the removal of the source, but flashed in when the rays played upon it. The sparker held near, but without the rays playing upon the specimens, gave no fluorescent effects. Therefore, no other conclusion is tenable than that it is the ultra-violet rays that produce this change. The same remark may be made for many of the experiments carried on with the sparker as the source of the ultra-violet light, in the examination of these mineral substances. On the other hand, this hyalite neither fluoresced nor phosphoresced when exposed to the magnesium light, Roentgen rays or radium, in this respect behaving like the minerals from Mono Lake; no hyalites from other localities responded to any of these activities.

8. By the action of ultra-violet rays a number of fluorites both phosphoresced and fluoresced; some phosphoresced and did not fluoresce; some fluoresced and did not phosphoresce; and some did neither. Further, their color had apparently no influence in determining this result; it can not be the fluorine or alkaline earth present that accounts for this variation, as artificial preparations gave negative results. It is more probably the presence of rare earths like yttrium and ytterbium. (A paper on this will appear.)

9. Chlorophane has long been known as a mineral very easily rendered luminous by heat. By some authorities it is stated, a century ago, that it was almost always luminous. This variety of fluorspar is found with other fluorspars—sometimes as a vein of purple between veins of green fluorspar. It proved very responsive to the ultra-violet rays. A variety from Amelia Court House, Virginia, became suddenly luminous from the heat of the hand.

This luminosity was lost upon further heating (about red heat) but the phosphorescent properties were restored in a measure by exposure to the Roentgen rays. Trowbridge has observed this with other fluorites (see above). The exquisite colored fluorescent properties were not regenerated however. Chlorophane is pyroelectric by attrition, and this peculiarity distinguishes it from the ordinary fluorites.

10. It was noted that gypsum from Sicily, when submitted to ultra-violet light, was from two to five times as responsive as specimens from Bavaria and other localities.

11. It was found that those topazes which had lost the sherry color—the tint so fleeting that some of the museums have been led to protect them from the light—showed no distinct phosphorescence with ultra-violet rays, while the unfaded crystals of that color responded, but no others.

12. Wernerite from New York phosphoresced, while specimens from foreign sources did not. Many apophyllites and calamines gave no response whatever.

13. Pectolite proved an exceptionally interesting mineral. Every specimen that was exposed to the ultra-violet rays showed

an active response; even some that were almost entirely altered to steatite. This is especially striking, as some of the specimens from New Jersey were loose delicate aggregates of needle-like crystals. Some were made up of crystals with a texture like felt; others of coarse crystals, and lastly the pectolite without any crystalline structure, homogeneous, and one time mistaken for jade, from Tehama County, California.

14. Wollastonite, whether from northern New York or associated with the rosolite garnet from Mexico, phosphoresced markedly, and with some duration, with ultra-violet rays, and responded strongly to radium (300,000).

15. Kunzite, the new variety of spodumene from Pala, California, when exposed to the action of radium of 300,000 activity for a few minutes, became wonderfully phosphorescent, the glow continuing persistently after the removal of the source of excitation. Six hundred grams of kunzite crystals were excited with 125 milligrams of radium bromide. Sir William Crookes in a personal letter, having repeated the experiment, remarks: 'I think this lilac variety of spodumene runs the diamond very close, if it does not surpass it sometimes.' Ultra-violet rays caused kunzite to phosphoresce for more than a minute This remark applies to the faded or colorless kind; the highly dichroic appears to resist. All forms of kunzite become phosphorescent with the Roentgen rays. So pronounced is this, that a large crystal excited for five minutes afterwards affected the film of a sensitive photographic plate. A thirty-second exposure caused three cut gems to glow first golden pink, then white for ten minutes, 20 times the duration of exposure to the X-ray, the glow penetrating two thicknesses of white paper. Another crystal of kunzite, exposed to the Roentgen rays for ten minutes, was then laid on a sensitive plate for five minutes. The resulting photograph was clear and distinct, but presented a very curious aspect not seen by the eye, as of a misty or feathery outflow from the side and termination of the crystal, suggesting an actual picture of invisible emanations. Kunzite is also pyroelectric, assuming a static charge, similar to topaz, when rubbed with a woolen cloth. It does not phosphoresce when heated.

16. The action of the quartz group was interesting. As a rule, quartz proper neither phosphoresced nor fluoresced with ultra-violet rays, allowing them to traverse it without any effect. Hence, the very few exceptions noted were doubtless due to the inclusion or intermixture of other substances. This was apparent in one or two cases of quartz pseudomorphs after barite and fluorite, which phosphoresced, evidently from the presence of some remainder of those minerals.

Chalcedonic quartz was also very unresponsive; one example only, from Uruguay, S. A., showing a bluish milky phosphorescence, and a specimen of agate in which one layer responded, between others that did not.

Opal, on the other hand, was frequently phosphorescent, very rarely fluorescent, and sometimes without any action. The variety quincite phosphoresced intensely, as did also specimens apparently pseudomorphous after gaylussite, which exhibited strong and long continued phosphorescence.

17. Among carbonates, calcite, witherite, strontianite and barytocalcite all phosphoresced; and aragonite, with occasional exceptions, was very marked in its action, far surpassing calcite. On the other hand, cerussite did not phosphoresce, save in a single specimen from Phœnixville, Pa.

There is here seen again the peculiar phenomenon noted in minerals from the Langban locality; and the suggestion is evident of the existence there, and at points where

similar exceptional results appear, as in Mono Lake, of the presence of some rare element (perhaps new) widely diffused in very minute quantities.

A similar indication is given by the behavior of the glauberite; those from Borax Lake, California, phosphoresced, as did those from Laramie and from Spain; while Chilian specimens did not.

18. It is notable that tourmaline, which is so markedly pyroelectric, gave no response; nor did beryl, save in three specimens from Haddam Neck, Conn.

19. American sapphires of various kinds, spinel, chrysoberyl, and almost all jades, declined to show any effects from ultra-violet rays. Most of the gem-minerals, except diamond, opal and kunzite, were little acted upon.

20. Only two of the rare earth oxides responded at all to the action of ultra-violet rays, namely, zirconium and thorium dioxides, which phosphoresced strongly. The thorium dioxide remained luminous in the dark for a greater length of time. The zirconium dioxide showed no radio-activity when tested by the electrical and photographic methods. It is strange that the two rare earths forming dioxides are the only ones to exhibit this property. The following oxides were examined: yttrium, ytterbium, erbium, gadolinium, samarium, lanthanum, cerium, neodidymium, praseodidymium, thorium, zirconium, titanium, uranium and variable mixtures of the same. They will be investigated further by one of us. (B.)

In view of the fact that these two earths give this characteristic response to ultra-violet rays, it became immediately of interest to learn the effect of these rays upon minerals carrying those substances in different proportions. The following selected minerals were subjected to the action of ultra-violet rays without a single one of them giving either fluorescence or phosphorescence.

Samarskite.—Berthier Co., Que.
Thorite (Orangite).—Arendal, Norway.
Thorite.—Barkevik, Norway.
Thorite (Auerlite).—Green River, N. C.
Sipylite.—Amherst Co., Va.
Columbite.—Portland, Conn.
Monazite.—Arendal, Norway; Zlatoust, Ural; 171st St. & Washn. Ave., N. Y., Amelia Court House, Va., Alexander Co., N. C.
Monazite sand.—Rio, Brazil.
Monazite.—Tvedestrand, Norway.
Xenotime.—Cheyenne Cañon, Colo.; Alexander Co., N. C.; Hitteroe, Norway.
Euxenite (in Samarskite).—Mitchell Co., N. C.
Æschynite.—Hitteroe, Norway.
Polycrase.—Near Marietta, S. C.
Fergusonite.—Llano Co., Texas; Ytterby, Sweden.

TENTATIVE CONCLUSIONS.

1. It seems as though in willemite, hydrozincite and the artificial phosphorescent zinc sulphide and zinc oxide, there is present, with the zinc, some element probably not yet determined, that possesses peculiar properties; one that in combination with a zinc mineral gives the high luminosity by the application of radium, the ultra-violet rays, or the Roentgen rays or other radio-active bodies; an element possibly accompanying zinc and possessing an affinity for it, as polonium has for bismuth, perhaps Phipson's actinium mentioned above.

2. It seems likely also that there exists in fluorspar either yttrium or ytterbium, or some other related rare earth, or perhaps several of them, from the variable action of this mineral with the various kinds of rays.

3. In the case of the numerous minerals coming from Borax Lake, so various in composition and yet all responsive alike to ultra-violet rays, there seems to be present some element which is very highly active, but is not responsive to radium, and which appears in every single mineral

found here. This is evidently a substance not necessarily radio-active itself, but one that may possess the same or allied properties with the substance found with the zinc minerals.

4. The substance present in calcite, from Franklin, N. J., and from Langban and Pajsberg, Sweden, is probably yet another body, which also does not respond to radium; although the willemite found with it at Franklin becomes luminous at the approach of radium as if it were a fairy wand.

5. There probably exists in autunite, and another yellow-brown uranium mineral from Texas, a fluorescent substance which differs from anything that we have noted in the study of the minerals of the collection.

6. In the hyalite, from San Luis Potosi, a volcanic mineral, there is present something that responds with a beauty of color that strikingly reminds one of nitrate of uranium; this may be still another substance.

7. The most responsive of all, however, were the diamonds containing that peculiar substance that gives them what is known as the blue-white color—fluorescent like anthracene, and holding the luminosity for a long time—to which one of us (K.) gave the name of Tiffanyite.

In the examination of more than 15,000 diamonds from British Guiana and elsewhere, 44 were selected. After an exposure of 60 seconds to ultra-violet rays, these 44 diamonds phosphoresced brilliantly and continued to glow for a long time after exposure. The luminosity was so great that it penetrated one thickness of white velvet and from nine to twelve thicknesses of tissue and blue linen paper. But they did not exhibit their light through black velvet, nor apparently were they affected by the ultra-violet rays when surrounded by black velvet. These diamonds when glowing brilliantly showed absolutely no action upon the barium platino-cyanide screen, nor upon screens of phosphorescent zinc sulphide, willemite or calcium sulphide.

The most remarkable specimen was a diamond of $14\frac{21}{32}$ carats. (This was exhibited.) This stone possesses the power of absorbing sunlight and emitting it in the dark. An arc lamp will cause it to store up light and to give it out in the dark. Even a small hand-lamp of one candle-power has caused this diamond to phosphoresce. It responds to polonium, to the Roentgen rays and to the utra-violet rays; to the rays that pass through a violet glass, and to radium, even in a more marked degree than willemite.

The print shown was made from a negative obtained by exposing a sensitive photographic plate to the blue-white diamond, and a transparent black stone of $16\frac{11}{16}$ carats, thin white paper intervening, after they had been exposed to ultra-violet light for one minute. The print is the result; except that the print of the black stone has been colored to show the reddish phosphorescence given out by it.

After another exposure of one minute, to our surprise, the black stone glowed red for fifteen minutes, almost surpassing the phosphorescence of the blue-white stone. At the end of fifteen minutes the red glow subsided, while the white stone phosphoresced five minutes longer; the light being held twenty minutes after exposure.

As stated above, from the work of Wiedemann and Schmidt, Hoffmann, and Trowbridge, it appears that the phosphorescent and fluorescent effects observed by the action of ultra-violet light, produced by sparking, with such metals as iron, is not due to this cause at all, but may be accounted for by the accumulation of an electric charge. The diamonds were

'grounded' by placing directly upon the iron radiator in the room and similar observations made, as when the precious stones were insulated.

It is interesting here to note that Marckwald reported the property of phosphorescence with polonium as belonging only to Brazilian diamonds. Rosenheim found that the rays from radio-active polonium possess the property of inducing fluorescence in a number of diamonds from different localities. The rays emitted by the diamonds under these conditions affect the retina and the photographic plate. "This actinic activity of the diamond," he says, "like its visible fluorescence, is entirely dependent on the presence of the polonium, not persisting after the removal of the latter. Even after long exposure to polonium rays no induced radio-activity could be detected." We found the fourteen and a half carat diamond from Brazil very responsive to the polonium; also some from British Guiana.

Almost all diamonds, of various weights and from many localities and of different colors, fluoresce and phosphoresce more or less with radium, except the black or carbonado. The degree to which these phenomena are observed is no criterion of the grade of the gem, however, as stones with flaws often fluoresced with even greater brilliancy than the pure ones.

8. It is quite evident through our study of the collection, that one or the other of these forms of luminosity and activity may have a value to detect elements or compounds that have escaped notice or are present in the minerals as impurities. These forms of investigation may also prove serviceable in chemical analyses. There should be a use for this line of research also in petrological determinations, as the slightest phosphorescence or fluorescence would aid in determining and locating a mineral, no matter how minute in quantity. This we have done in several instances.

The original ultra-violet lamp was that of Gorl, of Munich, altered by the English into the St. Bartholomew lamp, and again improved and made practicable in the United States under the name of the Piffard lamp, after Dr. H. G. Piffard, of New York. It is an instrument of great utility and, in the convenient form with which we worked, can not fail to prove a valuable mineralogical and chemical as well as medical adjunct. In fact, Dr. Piffard has used it with much success in medical practice. It will also be useful in many instances for mineralogical determinations—at times to detect impurities which have escaped analysts and others.

9. In all observations on the effect of radium, ultra-violet light and the X-rays to determine whether an object becomes fluorescent or phosphorescent under the influence of either, it is essential that the eyes become thoroughly accustomed to the change of conditions when one is in a dark room. This usually requires from ten to twenty minutes, and in some cases half an hour. Attention has been called to this by preceding observers. Whether it be due to the accumulation of the visual purple, which von Kries states is a substance that supplies the retinal basis of vision at low luminosities, and whose accumulation is accountable for the great increase in sensitiveness of the dark-adapted eye, or to the ordinary physical changes in the optical lenses, or partly to both, we do not undertake to decide. But it was found to be advisable that just before the source of excitation was removed from the material examined, the eyes be closed, and not opened again until after the removal. Else, as was noted, the residual flash that remained might be mistaken for phosphorescence. In most of the experiments carried on, three observers watched each

test. When there was the least disagreement, the tests were repeated a sufficient number of times until a unanimous agreement was arrived at.

10. The Roentgen rays have been used with great success to locate fractures, misgrowths, deformities and abscesses in the bony processes; but as far as we are aware, little success has attended efforts to locate ruptures, growths, or peculiarities of the veins, intestines, etc., by this means. There seems a possibility, however, that if a highly fluorescent or phosphorescent substance could be injected into the veins, the stomach or the intestines, it would be feasible to locate lesions, growths and other peculiarities of these organs; possibly also to locate accretions and kidney or bladder concretions, especially calcareous, as well as, possibly, peculiarities in the structure of the heart and other organs. This it might be practicable to do by means of inert but phosphorescing materials in solution given in the food, or injected into the stomach or intestines when they are quite empty. It might be that a nearer location could be effected in the organs desired to be examined, if impalpable powders be given with the food. It it were possible to inject such a substance into the blood, the entire vein structure of the body might be rendered visible as well as the bony part. It seems not unlikely that such an active agent as radium or ultra-violet light may yet be found a great accessory in diagnosis and autopsies, as they have given promise of marvelous curative values in certain diseases.*

11. The final part of the work planned was an investigation of the influence of cathode rays upon gems and the gem material of these collections. The method utilized in the classical investigations of Becquerel, Crookes and de Boisbaudran, on the fluorescence and phosphorescence of a number of substances, especially alumina and the rare earths, in vacuo, and spectroscopic examination of the light emitted therefrom, offers possibly an answer to questions as to the nature of such substances as give tiffanyite its unique properties, for example. Small amounts may be used; the destruction of such valuable gems in chemical analysis being out of the question. The time at our disposal having been utilized in securing the observations briefly outlined above, we were forced to discontinue the research for a time, although a number of Crookes' tubes have been charged with material and exhausted. We hope to complete that phase of the undertaking, but confess, from what has been indicated above, that things have been seen that shine like a 'pillar of fire by night' and beckon us on.

12. From the summarized observations on minerals related above, it appears that there are evidently two properties recognizable—radio-activity and a property that responds to this activity. It is hence seen that we have two classes of bodies—radio-active, and those that are affected by radio-activity; and that these groups may be again divided into several minor divisions.

We seem to find here an analogy to certain well-known facts in electricity and magnetism; some bodies that are active and others that are acted upon in several different forms, which are evidently closely related, and yet are distinct in their modes of action. We are privileged, therefore, to offer for mineral substances a

TENTATIVE CLASSIFICATION.

Those minerals:

1. Not responding to radium, ultra-violet or Roentgen rays.

2. Responding to radium only.

* After presenting this paper we were informed that Dr. Morton and Mr. W. J. Hamner have investigations along these lines now in progress.

3. Responding to ultra-violet rays only.
4. Responding to Roentgen rays only.
5. Responding to radium and ultra-violet rays (not to Roentgen rays).
6. Responding to radium and Roentgen rays (not to ultra-violet rays).
7. Responding to ultra-violet and Roentgen rays (not to radium).
8. Responding to radium, ultra-violet rays and Roentgen rays.

It is our purpose, further, to examine the same collections by the infra-red rays, for comparison with the ultra-violet; as it is quite possible that many minerals will give response of some kind with the infra-red that are not affected by the ultra-violet.

As for mineralogical determination, no large apparatus is necessary, as is used in medicine or for physiological investigations. In fact, very simple apparatus is sufficient. Therefore, we are devising a series of appliances such that the entire apparatus may probably be purchased for much less than one hundred dollars. And a photometer-like meter to measure the distance of penetration of the X-ray, the ultra-violet ray, and also the distance of the penetration of radio-active bodies.

We are also preparing a list of minerals, selecting those most readily obtainable, to illustrate these phases of activity or inactivity with the three useful accessories. For a small expenditure any school or college can obtain them for comparative study.

As the electric furnace has given us carborundum, artificial graphite and a series of absolutely *new* carbides, because with it we have attained temperatures of a height unknown before its introduction; and as the production of low temperatures has resulted in the liquefaction of all known gases and assisted in the discovery of new ones; so perhaps the application of these forms of energy may give us the means of identifying substances that have escaped all our earlier methods of observation; and it may be that we shall find a new series of elements. We are clearly on the threshold of a new field of scientific facts and perhaps generalizations and laws, which may yield results in the twentieth century as interesting and remarkable as the electrical discoveries were in the nineteenth. Indeed, some have already discarded atomic chemistry and assumed ionic chemistry, while pioneers like Crookes, J. J. Thomson and Lodge vouchsafe 'protyle,' 'corpuscles' and 'electrons,' with more or less experimental verification, although they do not quite reach Ostwald's metaphysical view.

Here we gratefully acknowledge the aid given us in free access to the collections, the construction of a special dark room, every facility of the museum's workshops, the encouragement and advice given by the museum's able director, Dr. H. C. Bumpus, and the attention and assistance of Dr. L. P. Gratacap, Mr. L. L. Seymour and Mr. Smith, of the mineralogical department, and of Mr. Dahlgren, the museum photographer.

SUPPLEMENTARY NOTE: ACTINIUM.

We have recently had the opportunity of making some experiments with a small amount of the exceedingly rare, novel, and hitherto almost unobtainable, element, actinium, described by Professor Debierne in the *Comptes Rendus,* 1898.

This actinium was a preparation of the oxide, with an activity of 10,000 (uranium being taken as unity), prepared by Dr. Debierne, and sent to one of us through the courtesy of Professor P. Curie. The emanations from it seemed most profuse, and although it had been exposed for two weeks, in a paper package in the mail, yet they were as energetic at the time of its arrival, and one week after, as they could have been at any time. The substance is wonderfully radio-active; in the few ex-

periments that we have made, it was found that, like radium, it causes the diamond to phosphoresce, and exerts the same action as radium upon kunzite and willemite, with the possible exception that the emanations from the small quantity of substance seemed to become luminous before they touched the willemite itself. The surface that was affected measured two square inches, many times the surface of the actinium. The effect produced on willemite was somewhat different from that due to radium; the luminescence apparently penetrated the willemite, and at the same time it almost seemed as if a luminous emanation left the material.

It was also found that on applying some powdered and granulated willemite to the inside of a closed jar, 12 cms. high, and putting this over the actinium, which was in a paper, the emanations made the entire interior of the jar luminous.

On the other hand, they do not appear to possess the penetrating power through glass that the radium compounds show; for in the same experiment they failed to affect the willemite on the outside of the jar, although the glass was only 1½ mm. in thickness.

A platinum-barium-cyanide screen immediately responded when the actinium was held against the black paper on the back. The abundance of emanations from the substance, rather than their penetrative quality, seemed to be its characteristic.

One of the properties of actinium which Professor Curie mentions in his letters, is the emitting of many emanations, which last for some minutes. This last feature, of endurance, was not observed. On the other hand, a peculiarity of actinium, as compared with radium, is that the emanations, although much more profuse, disappear in a few seconds. Another marked feature is a certain visibility or materiality of the emanations. This has been already referred to in some of the experiments above described in connection with willemite.

If actinium is placed in a paper over a screen of the phosphorescent sulphide of zinc (Sidot's blende), the screen will become illuminated, and on slightly blowing, so as to produce a current of air, the light is carried along the screen with the emanations. It was found that the diamond was affected quite as permanently as with radium; so was the spodumene variety, kunzite, and a specimen of willemite more than two inches square. Emanations of the actinium, which was in a double paper, rose in a cone-shaped form and spread out in an inverted cone on the base of the willemite, illuminating both.

GEORGE F. KUNZ,
CHARLES BASKERVILLE.

AMERICAN ORNITHOLOGISTS' UNION.

THE twenty-first congress of the American Ornithologists' Union convened in Philadelphia, Monday evening, November 16. The business meeting was held in the council room, and the public sessions, commencing Tuesday, November 17, and lasting three days, were held in the lecture hall of the Academy of Natural Sciences.

Charles B. Cory, of Boston, was elected president, Charles F. Batchelder, of Cambridge, Mass., and E. W. Nelson, of Washington, D. C., vice-presidents; John H. Sage, of Portland, Conn., secretary; Dr. Jonathan Dwight, Jr., of New York City, treasurer; Frank M. Chapman, Ruthven Deane, A. K. Fisher, Thos. S. Roberts, Witmer Stone, William Dutcher and Charles W. Richmond, members of the council.

The ex-presidents of the union, Drs. J. A. Allen and C. Hart Merriam, and Messrs. William Brewster, D. G. Elliot and Robert Ridgway are *ex-officio* members of the council.

Dr. Samuel W. Woodhouse, of Philadel-

phia; Professor Dean C. Worcester, of Manila, P. I.; Dr. E. C. Hellmayer, of Munich; Dr. Emil A. Goeldi, of Pará, Brazil; Dr. Peter Sushkin, of Moscow, and Dr. Herluf Winge, of Copenhagen, were elected corresponding fellows. Eight associates were elected to the class known as members, and one hundred and four new associates were elected.

At the opening of the congress Dr. A. K. Fisher delivered a memorial address on Thomas McIlwraith, who died in Hamilton, Ontario, January 31, 1903. Mr. McIlwraith was a founder and fellow of the union, and, although deeply engrossed in business, never lost his taste for ornithology. His writings relate mainly to the birds of Ontario, Canada.

Mr. Frank M. Chapman, in his account of an ornithological trip to the Pacific, brought forcibly to mind the exceptional opportunities afforded the eastern members of the union, by the Cooper Ornithological Club, to study the avifauna of the Pacific coast after adjournment of the special meeting of the American Ornithologists' Union held in San Francisco during May, 1903. Other results of the trip were shown at the present congress. Dr. T. S. Palmer spoke of the bird colonies of the California and Oregon coasts. Mr. Chapman exhibited most excellent views of Farallone bird life and described the different species found there, and Otto Widmann gave a list of the birds noted during a short stay in the Yosemite Valley.

A paper on bird life on Laysan Island, Hawaiian group—an interesting but little-known region—was presented by Walter K. Fisher and accompanied by fine examples of bird-photography. In the absence of the author the paper was read by Dr. A. K. Fisher, who also explained the slides. Laysan is said to be 'the greatest bird island in the world.'

Rev. H. K. Job showed a large series of lantern slides from photographs of birds taken in the bird rookeries of Cape Sable and the Florida Keys, and told of the ingenious expedients resorted to to secure good results.

Mr. Witmer Stone had gathered all obtainable material relating to John K. Townsend and William Gambel, and incorporated it in a paper of historical interest regarding these neglected ornithologists.

Mr. Geo. Spencer Morris spoke of bird life at Cape Charles, Va., and referred to the decrease in recent years among the water fowl found at that noted resort.

'New Bird Studies in Old Delaware,' by Samuel N. Rhoads and C. J. Pennock, brought out valuable ornithological facts relating to that apparently neglected state.

In his report of the Committee on Protection of North American Birds Mr. William Dutcher, the chairman, showed that satisfactory results had been obtained during the past year. This was made possible by the Thayer Fund money secured through the efforts of Mr. Abbott H. Thayer.

Following is a list of the papers read at the sessions:

In Memoriam: Thomas McIlwraith: A. K. Fisher.

Notes on the Bird Colonies of the California and Oregon Coasts: T. S. Palmer.

Nesting Habits of Florida Herons: A. C. Bent.

New Bird Studies in Old Delaware: Samuel N. Rhoads and C. J. Pennock.

The Æsthetic Sense in Birds: Henry Oldys.

Notes on the Protected Birds on the Maine Coast, with Relation to Certain Economic Questions: A. H. Norton.

Exhibition of Lantern Slides of Young Raptorial Birds, photographed by Thos. H. Jackson, near West Chester, Pa.: Witmer Stone.

Views of Farallone Bird Life: FRANK M. CHAPMAN.

The Bird Rookeries of Cape Sable and the Florida Keys: HERBERT K. JOB. Illustrated with lantern slides.

A Winter Trip in Mexico: E. W. NELSON. Illustrated with lantern slides.

Some Nova Scotia Birds: SPENCER TROTTER.

Nesting Habits of the Whip-poor-will: MARY MANN MILLER.

Some Variations among North American Thrushes: J. DWIGHT, JR.

The Spring Migration of 1903 at Rochester, N. Y.: E. H. EATON.

Warbler Migration in the Spring of 1903: W. W. COOKE.

Some Birds of Northern Chihuahua: WM. E. HUGHES.

A Reply to Recent Strictures on American Biologists: LEONHARD STEJNEGER.

The Exaltation of the Subspecies: J. DWIGHT, JR.

Variation in the Speed of Migration: W. W. COOKE.

An Ornithological Excursion to the Pacific: FRANK M. CHAPMAN. Illustrated with lantern slides.

Bird Life on Laysan Island: WALTER K. FISHER. Illustrated with lantern slides.

Ten Days in North Dakota: W. L. BAILY. Illustrated with lantern slides.

Two Neglected Ornithologists—John K. Townsend and William Gambel: WITMER STONE.

Bird Life at Cape Charles, Virginia: GEORGE SPENCER MORRIS.

San Clemente Island and its Birds: GEO. F. BRENINGER.

Yosemite Valley Birds: O. WIDMANN.

The Origin of Migration: P. A. TAVERNIER.

A Contribution to the Natural History of the Cuckoo: M. R. LEVERSON.

Mortality among Young Birds due to Excessive Rains: B. S. BOWDISH.

Collecting Permits: Their History, Objects and Restrictions: T. S. PALMER.

Report of the Chairman of the Committee on the Protection of North American Birds: WM. DUTCHER.

The next annual meeting will be held in Cambridge, Mass., commencing November 28, 1904.

JOHN H. SAGE,
Secretary.

SCIENTIFIC BOOKS.

JOHNS HOPKINS HOSPITAL REPORTS. VOL. 11, NOS. 1-9.

THIS report contains three articles. The first is an exhaustive and valuable monograph on pneumothorax by Dr. Emmerson, covering 450 pages. The literature of the subject, going back to the works of Hippocrates, and coming down to the present time, is given in the form of abstracts, translations or quotations from the original articles. This necessitates much more space than is usually devoted to literature, but it must be admitted that in many respects it is more satisfactory than the references ordinarily made. The first chapter is devoted wholly to these abstracts. In Chapter II., entitled 'The History of Pneumothorax,' the facts stated in the abstracts already given are satisfactorily woven together. Chapter III. is devoted to the etiology and pathology of the disease, with clinical histories of cases. While there is much of interest in this chapter, it can not be said that it contains any important contribution to our knowledge of the disease. Chapter IV., on 'The Mechanism of Pneumothorax,' is, in our opinion, the most interesting, and in some respects the most valuable part of this monograph. Your reviewer has been especially interested in the work done by Dr. Emmerson, as well as the literature which he has collected bearing upon the composition of the gas accumulation in the chest in this disease. His conclusions are stated as follows:

"1. There is a rapid accumulation of CO_2 in the pleuræ after death, which fact rules out the majority of analyses yet published.

"2. The presence of a purulent exudate is an important element in determining the composition of the gas.

"3. This post-mortem accumulation of CO_2 may explain the high tension of the gas, which hisses from the chest on the autopsy table.

"4. The method of diagnosing an open fistula proposed by Leconte and Demarquay seems to be valid."

Preceding authors have largely, if not altogether, failed to recognize the fact that the composition of the gas found in the pleura in pneumothorax is, in part at least, dependent upon the character of the microorganisms contained in the accompanying exudate. We know that certain bacteria consume oxygen and give off carbonic acid gas, while still others break up proteid material and elaborate H_2S and possibly $(NH_4)_2S$. It is not, therefore, surprising that there has been much diversity of statement concerning the composition of the gas in pneumothorax. Our author certainly makes it clear that these variations are to be expected.

The second paper is entitled 'Clinical Observations on Blood Pressure.' This is always an interesting subject to both the physiologist and the clinician. The instrument used in these observations was a modified Riva-Rocci sphygmomanometer, which gives very satisfactory results. The experiments made upon the effects of anesthesia upon blood pressure confirm the views now quite universally held by the best surgeons in this country; that is, that chloroform, on account of its depressing action, and the consequent low blood pressure, is a much more dangerous anesthetic for surgical operations than ether. The authors of this paper, Cook and Briggs, bring out the fact, so well known to obstetricians, that the depressing action of chloroform is not manifest when this anesthetic is used in labor. The most interesting part of this paper, to your reviewer, at least, is that which deals with the effects of strychnin and digitalin in cases of shock. Most clinicians of wide experience have become very positively convinced that strychnin, especially, is valuable in shock, but this has recently been denied by Crile, whose most interesting and valuable work upon this subject demands respect. Crile holds that the employment of strychnin in shock is irrational because, according to him, in this condition the vaso-motor center is completely exhausted, and no good is to be secured by 'flogging the tired horse to death.' Notwithstanding the conclusion reached by Crile, the majority of clinicians think that they have had in their experience ample and frequently repeated evidence of the value of strychnin in shock, and it is gratifying to know that Cook and Briggs in the paper now under review have shown that in eight out of ten cases of shock under central stimulation with strychnin, digitalin or cocain, positive improvement has been secured. It is only fair to state that this difference between Crile and other clinicians is largely a matter of words. Crile recognizes as 'shock' only those cases in which strychnin does no good, and he designates by the term 'collapse' other cases in which central stimulation is of value; but inasmuch as no one, not even the operator himself, can distinguish between the two in many instances, the clinician will undoubtedly continue to use strychnin in shock, and in doing this will be justified by the experimental observations recorded in the article now under consideration.

The third paper in this volume is entitled 'The Value of Tuberculin in Surgical Diagnosis,' and is presented by Dr. Tinker. While this article is of value, inasmuch as it confirms the findings of a number of others who have investigated the subject, it can not be said to furnish us with anything new. The author concludes that tuberculin, properly employed, is a valuable agent, and, we may say, the most valuable agent in our possession in the diagnosis of latent tuberculosis, and is harmless.

V. C. Vaughan.

SCIENTIFIC JOURNALS AND ARTICLES.

The Psychological Review will hereafter be edited by Professor J. Mark Baldwin, of the Johns Hopkins University, and Professor H.

C. Warren, of Princeton University. The editors announce that beginning with January 15, there will be issued monthly a literary section devoted especially to reviews of the literature.

The British Journal of Psychology, edited by Professor James Ward and Dr. W. H. R. Rivers, of Cambridge University, with the co-operation of Messrs. W. McDougall, C. S. Myers, A. F. Shand, C. S. Sherrington and W. G. Smith. The first number will be published in January by the Cambridge University Press and the parts will thereafter be issued at irregular intervals, about 450 pages constituting a volume, the price of which is 15s. The following papers will appear in early numbers:

J. WARD: 'On the Definition of Psychology.'

C. S. SHERRINGTON: 'On the Interrelation between Corresponding Retinal Points.'

J. L. MCINTYRE: 'A Sixteenth Century Psychologist, Bernardino Telesio.'

W. MCDOUGALL: 'The Sensations Excited by a Single Momentary Stimulation of the Eye.'

C. S. MYERS: 'The Taste-names of Primitive Peoples.'

R. LATTA: 'A Case of Recovery from Congenital Blindness.'

W. H. R. RIVERS: 'Observations on the Senses of the Todas.'

Also papers by F. W. MOTT, A. F. SHAND, H. HEAD and others.

The Proceedings of the Psychological Society will also be published in the Journal.

MR. F. SHILLINGTON SEALES will, from January next, edit in *Knowledge* the columns devoted to microscopy; still further space is to be given to this subject in our contemporary in the new year.

THE catalogue division of the Library of Congress has sent to press, and will issue shortly, through the office of card distribution, a set of analytics for Engler-Prantl's 'Die natürlichen Pflanzenfamilien.' Each article (family) in this important set of monographs will be represented by a separate catalogue card, which contains full bibliographical information, including exact dates of publication for undated signatures. Beside subject headings, all added entries will be printed in full. The cards covering the unfinished portions of the work will be issued upon the completion of the volumes in question. The number of titles now going to press is 458, and the total number of cards necessary for main entries, subjects and added entries will be 936. These may be obtained at the office of card distribution. The task of analyzing this and other collective works of similar importance, titles of which will be announced later, has been performed by Mr. J. Christian Bay. Owing to the exacting demands of necessary work in other directions, the library has so far undertaken but little work of this character.

DISCUSSION AND CORRESPONDENCE.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

TO THE EDITOR OF SCIENCE: As the St. Louis meeting of the American Association and its allied societies is drawing near, I beg the privilege of making, through the columns of SCIENCE, a suggestion to those, who I hope are many, intending to appear before Section B at that meeting. I think the general opinion of those who attended the Washington meetings of this section and of the Physical Society, which cooperated, is that the matter presented was, as a rule, very good, and that the manner of presentation was, as a rule, very bad. The habit of us physicists is to put in, before the meeting, a very modest claim for time, ten or fifteen minutes, when we have ample material for twenty or twenty-five, and then when we have the floor, to proceed as if we were giving a one-hour lecture in a course running through the year. Very few of our talks at society or association meetings give the impression of being thoroughly thought out, with a view not only to the subject, but to the audience as well. What we call 'papers' are apt to be rather disordered, imperfectly considered remarks about our papers, which in some cases are still to be written.

My suggestion is that every man who intends to make a communication to Section B at the coming meeting shall ask for as much time on the program as he is at all likely to need, and that, keeping his time allotment

strictly in view, he shall strive, days in advance, to put his matter into the most intelligible and attractive form. It should be remembered, too, that in the oral presentation of a subject before a friendly audience, it is better to give the hearers a chance to ask for more information, if they want it, or for fuller proof of statements made, if they think it needed, than to overwhelm and deaden them from the outset with a mass of details and an elaboration of argument.

Edwin H. Hall,
Vice-president of Section B.

THE ST. LOUIS CONGRESS OF ARTS AND SCIENCE.

To the Editor of Science: By chance, I had at first overlooked Professor Dewey's reply (Science, November 20) to my letter concerning the St. Louis Congress (Science, October 30). My answer thus comes late, but fortunately, the matter itself needs no further word, since all the questions involved, as far as they are of scientific import, were fully disposed of in my long letter. But Professor Dewey, in spite of the friendly tone of my answer, has now introduced in a most surprising manner a personal element, and that forces me to send a word of reply after all. He does not discuss the statements of my letter, by which practically all of his previous objections are proved futile, but he now turns the question so as to make it appear that I have made claims in my May article in the *Atlantic Monthly* which I had no right to make; he even ends with the climax that excuses are due from me to the editor and the readers of the *Atlantic*.

I had claimed in the *Atlantic* that the program of the congress adopted by the proper authorities involved a certain philosophical standpoint and a certain logical view of the sciences. When Professor Dewey expressed in his first remarks the idea that the program might exclude those who hold other views, I used the chief part of my reply to show that such a fear is unjustified. I showed that a man may have any views as to the logical relations of the sciences, and yet contribute in his special section with full freedom in spite of the framework of our program. It is evident that my article and my letter harmonize perfectly. But Professor Dewey considers the fact that I did not speak of the philosophical bearing once more in my letter as a kind of confession that such bearing does not and probably never did exist.

I did not repeat my assertion because I had stated the case very fully in the *Atlantic;* but there was not the slightest reason to withdraw a single word. No one who understands anything of methodology can see the program without observing that it has a meaning as a whole only when certain philosophical views are accepted. In the meetings of the boards for final decision I explained the logical reasons for this specific classification fully, and, accustomed to the rhythmical attacks of Professor Dewey on my philosophy, I pointed out why a philosophy like his would appear to me an unsatisfactory basis for the work of the congress and why an idealistic program was essential. Perhaps I may add an external proof of the correctness of my assertions. When my exposition of the situation had appeared in the *Atlantic Monthly,* the director of the congresses asked me to allow it to be reprinted as a pamphlet for official distribution—in short, if Professor Dewey insists that apologies are due in connection with my *Atlantic Monthly* essay, it seems clear that they are not due to the editor and to the readers, but to the contributor. Hugo Münsterberg.

Harvard University,
December 3, 1903.

RIGHT-HANDEDNESS: A PRIMITIVE AUSTRALIAN THEORY.

The attempts of primitive peoples to explain biological or physiological facts are not always of a purely mythic order. The blacks of the Tully River, North Queensland, Dr. Roth (*N. Queensl. Ethnogr. Bull.,* No. 5, 1903, p. 25) informs us, 'say, that at actual birth, according as the child presents its face to the left or to the right, so will it be left- or right-handed throughout life.' This seems a clear instance of aboriginal 'scientific' reasoning, and the theory deserves record at least in the history of the discussion of the question.

The blacks of the Pennefather River account

for right-handedness and left-handedness in quite a different way. According to their belief, Anjea, the mythological fashioner of babies makes them all right-handed, but Thunder (who really existed before Anjea and made him) can also form infants and, whenever he makes any, they are all left-handed.

ALEXANDER F. CHAMBERLAIN.

CLARK UNIVERSITY,
November 6, 1903.

SOCIETIES AND ACADEMIES.

NEW YORK ACADEMY OF SCIENCES. SECTION OF GEOLOGY AND MINERALOGY.

THE regular meeting of the section was held on November 16 at the American Museum of Natural History. The first business was the election of officers for the year 1904, and Professor James F. Kemp was elected chairman, and Dr. Edmund Otis Hovey, secretary.

The first paper of the evening was by Doctor A. W. Grabau, of Columbia University, and was entitled 'Discussion of and Suggestions Regarding a New Classification of Rocks.' The speaker said in part that all classification ought, as far as possible, to be genetic or according to progressive development. Such a classification is practicable in the biologic sciences, but not in those which, like mineralogy, deal with inorganic substances. In developing his theme the speaker suggested the following provisional subdivisions: Endogenetic rocks, or those formed by chemical means, and exogenetic or clastic rocks, which are chiefly of mechanical origin. The first group was further subdivided into pyrogenic or igneous rocks; hydrogenic or aqueous rocks; biogenic or organic rocks. The hydrogenic and biogenic rocks were each again subdivided into rocks of calcareous, silicious, ferruginous, carbonaceous and miscellaneous composition; and a further subdivision was made into unaltered and altered or metamorphic types.

The exogenic or clastic rocks were divided into autoclastic, hydroclastic, pyroclastic, bioclastic and anemoclastic.

A further subdivision according to texture was into rudaceous or conglomeratic, arenaceous or sandy, and lutaceous or mud rock.

The next division was according to composition into two main groups, silicious and calcareous, and finally into unconsolidated and consolidated and metamorphic rocks.

In the discussion of the paper Professor Stevenson spoke of the value of such a classification through its giving to teachers ideas for presentation to their classes regarding the interrelations of rock. Professor Kemp spoke of the system as being well adapted to geologic study on account of its giving the surroundings in which any specified rock has developed, although it is not practicable to assign a place to every small rock group which is really of mineralogical rather than of geological value.

The second paper of the evening was by Wallace Goold Levison, 'Notes on Fluorescent Gems.' The author said, in abstract:

Fluorescence, or the property of reducing the wave-length of certain luminous rays, enhances the beauty of a few colored gems under conditions which lessen the effectiveness of others that do not possess this property. Garnet, for instance, which is non-fluorescent, loses its rich crimson color and becomes dull gray in pure blue light. On the contrary, most kinds of ruby and ruby spinel and pink topaz respond to light rays above the red on account of their fluorescence, and in blue-violet light still display their characteristic tints. The red color of the ruby is somewhat developed by the light of the air-gap spark and an uncovered Crookes tube. It is intensely excited by the cathode rays. Willemite displays a beautiful greenish-yellow color not only in ordinary light rich in the yellow-green rays, but also in light consisting chiefly or wholly of the more refrangible colors in which its characteristic color would be effaced but for the possession of fluorescence in high degree. This mineral is excited furthermore by some of the ultra-violet rays and by the Roentgen and Becquerel rays.

Other materials which owe desirable tints to fluorescence are pearl, opal, hyalite, chalcedony and kunzite (the new lilac spodumene). Hiddenite, the green spodumene, seems to be non-fluorescent. Impaired by fluorescence are

triphane, a yellowish-green spodumene, which exhibits pink fluorescence in blue light; emerald, which shows crimson fluorescence in the upper part of the spectrum, and diamond, with greenish-blue to blue fluorescence excited by several kinds of energy but more or less masked in ordinary light.

In fluorescent substances excitation produces a certain opalescence or milkiness which is sometimes of sufficient strength to be of importance. It can not be taken as an indication of impurities in the materials. In the white diamond such a phenomenon is a detrimental quality.

Fluorescence affords a simple and positive method of distinguishing some of the fluorescent gems from imitations. Glass is not fluorescent and hence is easily detected. Other compositions when fluorescent show different colors from the genuine stones. In doublets the cement appears as an opaque film and the components differ in behavior. Artificial pearls of high grade have not been examined, but probably they will behave like the genuine. Artificial, or 'regenerated,' ruby has been examined in a single specimen. It acts like the natural stone in blue light, while with the air-gap spark between iron or aluminum electrodes it has a brighter color than any of the several natural rubies which were examined.

The following gems were stated to be non-fluorescent: Garnet, amethyst, Spanish topaz, yellow Brazilian topaz, sapphire, ordinary beryl, possibly Siamese ruby.

In the discussion of Mr. Levison's paper Professor Kemp expressed the hope that there would be a practical outcome from such investigations which would enable those not experts to detect false or artificial gems; Mr. Kunz said that there were simpler ways than the use of fluorescence for the determination of gems, and Professor D. S. Martin emphasized the desirability of getting definite information as to the wave-lengths to which gems respond.

The third paper of the evening was 'Mineralogical Notes,' by Dr. George F. Kunz, in the course of which the author exhibited white compact garnet from Fresno County, California, associated with the newly described compact vesuvianite, or 'californite.' In connection with these two compact minerals attention was called to the third compact mineral 'pectolite,' which was described some years ago by W. P. Blake. Pyroelectric zinc blende associated with wollastonite from Mariposa County, California, also was exhibited.

Edmund Otis Hovey,
Secretary.

THE TORREY BOTANICAL CLUB.

The club met at the Botanical Garden on November 25.

Dr. Britton read a memorial on the life work of the late Mr. Cornelius Van Brunt. It was ordered spread on the minutes and printed in *Torreya* as part of the proceedings.

The principal paper on the scientific program was by Mrs. Britton, entitled 'Notes on Further Botanical Explorations in Cuba.' The party consisting of Dr. and Mrs. Britton and Mr. Percy Wilson went to Cuba by way of Tampa, Florida, going direct to Matanzas, which point was reached on August 27. Extracts were read from her diary giving an interesting account of the daily happenings during the exploration of the region about Matanzas, Cardenas and Sagua. Many photographs were shown illustrating the regions visited, and specimens of some of the more conspicuous plants were exhibited. As the herbarium material secured by the expedition has not yet been studied, no detailed account of the botanical features of the region was attempted. All of this part of the island has been devastated by war. There is no primitive forest, and comparatively few large trees are left standing. On the return a few days were spent in Havana, visiting the botanical institutions of that city.

Dr. Britton exhibited specimens of what seem to be two species of hackberry. The common *Celtis occidentalis* of the eastern states is a small tree seldom exceeding forty feet, having smooth, slightly acuminate leaves and globular orange-colored fruits. On an excursion of the Torrey Club to the Delaware Water Gap some years ago, some much larger trees were observed growing in moist locations and having long acuminate leaves and oval

fruits. This seems to be the *Celtis canina* of Rafinesque. It is somewhat widely distributed, its range overlapping to some extent that of *C. occidentalis,* but it always occurs on moister, richer lands and grows to be a much larger tree.

F. S. EARLE,
Secretary.

THE BIOLOGICAL SECTION OF THE ACADEMY OF SCIENCE AND ART OF PITTSBURGH, PA.

THE section held its first regular business meeting, Tuesday, November 3, in the lecture hall of the Carnegie Institute.

The section was organized on October 9 by a number of members of the academy, who are interested in biological science. The officers of the section are:

President—George H. Clapp.
Vice-President—Professor R. H. Ridgeley.
Secretary-Treasurer—Frederic S. Webster.

President Clapp introduced the speaker of the evening, Dr. A. E. Ortmann, curator of the department of invertebrate zoology of the Carnegie Museum, who addressed the section 'On the Progress of Zoogeographical Investigations during the Last Ten Years,' which was followed by a general discussion by members of the section.

Regular meetings of the section will be held on the first Tuesday evening of each month.

Professor J. B. Hatcher, Dr. A. E. Ortmann and Professor Edward Rynearson were appointed as members of the 'Publication Committee.'

FREDERIC S. WEBSTER,
Secretary-Treasurer.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY GEOLOGICAL JOURNAL CLUB.

THE club, which organized in October, 1903, has, during the past month, reviewed the following articles:

R. H. Allen, 'The Oil Fields of the Texas and Louisiana Coastal Plain' (by C. W. Hayes and William Kennedy, in Bull. 212 U. S. G. S.); S. Shapira, 'Copper Deposits of New Jersey' (by W. H. Weed, in Geol. Surv. N. J. An. Rep., 1902); F. S. Elliot, 'Topographic Features of the Yosemite Valley' (by J. C. Branner, in *Jour. Geol.,* September–October, 1903); E. Burton, 'Earth Movements in the Bay of Naples' (by R. T. Günther, in *Geog. Jour.,* September, 1903); H. W. Shimer, 'The Skull of the Imperial Mammoth' (*National Geog. Mag.,* October, 1903); Mr. Shimer also spoke of other fossil mammoths and of boring clams; W. G. Ball, 'Mining in the Kirghez Steppes' (*Eng. and Min. Jour.,* November 14, 1903); C. E. Danforth, 'Cretaceous Auriferous Conglomerate of the Cottonwood Mining District, California' (*Eng. and Min. Jour.,* October 31, 1903); R. W. Senger, 'Lithia Deposits' (by W. F. Shaler, in *Bull. Univ. Cal.,* Vol. III., No. 13); M. Rubel, 'Notes on the Michipoten Gold Belt' (*Eng. and Min. Jour.,* October 31, 1903); G. G. Wald, 'Some Natural Resources of Michigan' (An. Rep. Mich. Geol. Surv.).

The following papers were given:

Professor W. O. Crosby, 'The Deflection of the Merrimac River,' also 'A Description of the Formation at the Old Nickel Mine at Dracut, Mass.'; F. G. Clapp (U. S. G. S.), 'Methods of Geological Surveying in Western Pennsylvania'; G. F. Loughlin, 'The Formation at Mine La Motte.'

G. F. LOUGHLIN,
Secretary.

ASSOCIATION OF TEACHERS OF MATHEMATICS IN THE MIDDLE STATES AND MARYLAND.

ON Saturday, November 28, about 300 teachers met in the Milbank Memorial Hall, Teachers College, New York City, and organized an Association of Teachers of Mathematics in the Middle States and Maryland. Almost all the colleges and large schools within the territory named were represented, and considerably more than 200 persons enrolled as foundation members of the society, whose prime object is the improvement of mathematical teaching. Professor David Eugene Smith, of Teachers College, was elected president of the association; Professor H. B. Fine, of Princeton University, vice-president; and Dr. Arthur Schultze, of the High School of Commerce, New York City, secretary.

The meeting, which consisted of a morning and afternoon session, offered many points of interest to mathematical teachers. After President Butler of Columbia University had delivered the address of welcome, papers on various phases of mathematical teaching were read by Mr. Harry English, of Washington, D. C., Mr. Isaac N. Failor, of Richmond Hill, Mr. Arthur Schultze, of New York City, and Mr. J. L. Patterson, of Philadelphia.

A mathematical exhibition of models, calculating machines, teaching devices, rare mathematical books, portraits of famous mathematicians, etc., in the museum of Teachers College, greatly added to the interest of the occasion.

The next meeting of the association will be held at Columbia University, New York City, about Easter time, and applications for membership and other communications may be addressed to Arthur Schultze, secretary, No. 4 West 81st Street, New York City.

In addition to the officers, the following were elected as council of the association: Professor John S. French, Jacob Tome Institute, Port Deposit, Md.; A. M. Curtis, State Normal School, Oneonta, N. Y.; Harry English, Director of Mathematics, Washington high schools, Washington, D. C.; John R. Gardner, Irving School, New York City; W. Z. Morrison, Shadyside Academy, Pittsburgh, Pa.; Mary V. Shea, Commercial High School for Girls, Philadelphia, Pa.

SHORTER ARTICLES.

THE PELÉ OBELISK.

The most remarkable phase of the still continuing eruption of Monte Pelé is the appearance on the summit of the mountain of a column of solid rock which is a conspicuous feature even when seen from a distance of fifty or more miles. The nature of this 'obelisk,' the changes it has undergone, its rate of ascent, etc., have been faithfully reported by Professor A. Lecroix, Professor Angelo Heilprin, Major W. M. Hodder, Dr. E. O. Hovey and others,* but a more comprehensive statement than I believe has yet appeared in print, as to the place to be assigned it in the sequence of events normal to volcanoes, may be of interest to the general reader.

The earlier of the recent eruptions of Monte Pelé and all of those of La Soufrière of St. Vincent since early in May, 1902, as will be remembered, were explosive. Neither volcano has as yet discharged a stream of liquid lava. During the explosive eruptions referred to, vast quantities of angular rock-fragments were blown into the air, and fell on the adjacent land and sea. The material thus showered on Martinique and St. Vincent consists for the most part of fresh lava, but contains also large quantities of fragments of rock of older date, which were torn from the inner walls of the conduits through which the explosive discharges took place, and in addition on the sides of each volcano there are many 'bread-crust bombs' as they are termed, or masses of lava frequently two feet or more in diameter, that were blown out of the craters in a plastic condition and assumed rudely spherical forms during their aerial flights. A large portion of the fragmental material, but more especially that composed of fresh lava, is in the condition of fine dust-like particles.

The nature and explanation of the explosions referred to may be readily appreciated by picturing in fancy, as may be done from the evidence in hand, the sequence of events during the eruptions.

A volcano, it will be remembered, is a tube or *conduit* leading from the earth's surface sufficiently deep into its interior to reach a region of intense heat. In the case of the Antillean volcanoes under consideration, the conduits may be considered as rudely circular in cross section and approximating five or six hundred feet in diameter, and of great but unknown depth. Through the conduits rock material so hot that it was molten or rather as is more probable, because of the great pressure present, in a plastic and viscous condition, or a *magma*, as it is convenient to term it, was forced upward from a depth and reached or made a near approach to the bottoms of the craters from which the products of the explosions were blown out. The magma

* Science, November 13, 1903, Vol. XVII., pp. 633–634. *American Journal of Science*, October, 1903, Vol. XVI., pp. 269–281.

as it rose lost some of its heat, principally on account of the cooling effect of the water which gained access to it, and as it approached the summit of the mountain, changed to a solid and rigid condition. Steam explosions occurred in the congealed portion, of such intensity that it was shattered, much of it being reduced to dust, and the fragments produced blown heavenward. During the greatest of the explosions the projected fragments were hurled to a height of four or five miles.

In the manner briefly outlined above, the rigid summit portion of the rising columns within the craters of the volcanoes was removed and fresh material was forced upward from a depth to take its place, and the process repeated. There was thus a transfer of material from deep within the earth to its surface just as truly as if an overflow of molten rock had occurred. In fact the material blown out by Pelé or by La Soufrière would in each instance, if melted and run together, form an extensive lava flow, or one, I venture to say, exceeding in volume all of the lava discharged by Vesuvius during the eruptions of 1872.

The eruptions thus far considered may be termed fragmental-solid discharges, except that on both Martinique and St. Vincent a minor portion of the material extruded was in a plastic condition when blown into the air. This still plastic material probably came to the surface during the later stages of several of the eruptions which furnished the solid angular fragments.

La Soufrière has exhibited only the explosive phase of solid eruptions, but Monte Pelé has undergone another and much more novel variation of the same process. Succeeding the earlier and more intense explosions in the summit portion of the conduit of the volcano on Martinique, the solid lava in its throat was forced upward in a massive condition until, in spite of many losses, it stood at one time about 1,600 feet higher than the rim of the crater from within which it was protruded. Its rate of ascent for a period of eighteen days, as observed by Major Hodder, was forty-one feet per day. The massive tapering column, or 'obelisk,' was approximately 600 feet in diameter near its base, and composed of solid or massive rock, and not of angular fragments or adhering cinder-like scoria, as in ordinary cones of eruption. Light was emitted from fissures in its sides, and steam escaping from it showed also that its interior was still hot. The fall of material from the summit and sides of the obelisk and at times its nearly complete destruction, may be accounted for by its structural weakness and by the occurrence of steam explosions owing to rain-water gaining access through fissures to its hot interior. A still more important agency leading to its diminution appears to have been furnished by steam explosions about its base. Then, too, as will be understood, a huge irregular plug of solid rock was being pushed out by pressure applied beneath, through an irregular opening in still more rigid rock, and many jars and tremors must have occurred which would tend to dislodge masses of material from the sides and summit of the ascending plug. Allowing for the losses due to these various causes, the elevation which the obelisk would have attained, had it suffered no loss in height, can reasonably be estimated at not less than three thousand feet.

The obelisk is evidence that the upward movement of the material in the conduit beneath it did not cease when explosions in its rigid summit portion failed to remove material as fast as it rose from a depth, but continued and was the cause of the forcing out of the summit of the plug in the manner described.

As the rock composing the obelisk was still hot even after rising high in the air, the decrease in the energy of the explosions which accompanied its growth can not be ascribed to the lack of the necessary heat to vaporize water. The only other alternative seems to be that the rate at which water gained access to the summit portion of the volcano's conduit diminished, or there was a marked decrease in the vapor content the rising magma brought from a depth.

Thus far, as may reasonably be claimed, the conclusions reached are a direct and legitimate deduction from the facts observed. We

can take still another step, but with less confidence, in the same direction.

In reference to the proximate source of the water which changed to steam, which is a conspicuous accompaniment of all volcanic eruptions, there are two leading hypotheses; one, to the effect that it is derived mainly from a deep source and was present in a state of solid solution in the magmas supplied to volcanoes before their migration outward from the earth's interior, and, also, that the steam thus occluded, or its component gases, is expelled as loss of heat occurs and the magmas change from a liquid or a plastic to a solid condition; and the other, that water descends from the earth's surface and meets the ascending magmas and becomes occluded in them and at the same time decreases their temperature.

To be sure, both of these hypotheses may be true, and both of the processes referred to be in action at the same time; but even if such were the case, it is to be presumed that one source of water supply or the other would be dominant and in control.

One of the most interesting questions in connection with the obelisk of Pelé is in reference to the evidence it furnishes favoring one or the other of the hypotheses referred to.

If the steam given off by the volcano was an original or primary constituent of the magma which rose in its conduit, it is reasonable to suppose that the distribution of vapor or gases in the magma before its upward migration would be essentially uniform in all parts of the 'reservoir' from which it was supplied. This assumption, as must be freely admitted, is not susceptible of direct proof, but the little which is known concerning the diffusion of gases in liquids seems to demand that the tension in all parts of a relatively restricted mass of the magma in the subcrustal portion of the earth shall be the same. It may be argued that such a conclusion is not permissible in view of our almost total ignorance of the condition of matter under the influence of pressures and temperatures such as exist at a depth in the earth, but as the volcanic problem now stands, it certainly does not seem reasonable to suppose that there can be any conspicuous variations from place to place in the primary vapor content of the magma which supplies a single volcano. That is, we have no reason for concluding that the material which was forced upward in the conduit of Monte Pelé, while yet deep in the earth, was in a pronounced degree vapor-charged in one part more than another, and can not appeal to such a supposed variation to account for the diminution in the energy of the explosions in the summit portion of the conduit, or the accompanying change in the material extruded from a fragmental to a massive-solid condition.

Under the hypothesis that the steam given off by volcanoes has its chief source in the water supplied by downward percolation, or descends from the earth's surface through fissures, etc., and meets an ascending magma, the rate of such supply may reasonably be considered as variable and its depletion possible in case great demands are made upon it.

How surface water is enabled to reach a volcano's conduit, and the methods by which it is absorbed or passes into a state of solid solution, are again obscure, but these questions may well be left in abeyance, during the search for evidence as to the source or sources from which the water is derived.

In the instance before us, the evidence seems to show that the earlier explosions exhausted, or at least greatly depleted, the water within reach of the volcano's conduit, and in consequence the conspicuously violent eruptions ceased and the rigid although still hot plug of lava in its summit portion was forced upward by pressure beneath its base and rose far above the rim of its encircling crater. In this connection also it may be noted that the access of water to the summit portion of the conduit of the volcano seems essential to account for the observed cooling and hardening of the rising magma at that locality; on the other hand, the fact that the rigid lava was not shattered and blown to fragments suggests that water in considerable quantity did not gain access to it. In reference to these and many other questions bearing on the theory of volcanoes, the reports of the detailed observations that are being made on

the behavior of Pelé by the French commission, will be looked for with interest.

ISRAEL C. RUSSELL.

CURRENT NOTES ON METEOROLOGY.

METEOROLOGICAL BIBLIOGRAPHIES.

IT is likely that but few persons will be perfectly satisfied with any single volume of the 'International Catalogue of Scientific Literature,' but the help to be gained from the different volumes is so great that it seems rather ungrateful to make adverse comments. Any one who has endeavored to keep a complete card catalogue of the current literature in even one science will necessarily appreciate these volumes much more fully than he who has not spent many weary hours in the monotonous labor of copying titles from scientific journals. The writer has, since 1887, the date with which the 'Signal Service Bibliography of Meteorology' ended, kept for his own use, and that of his students, a fairly complete card catalogue of meteorological literature, not only of original articles, but also of notes, abstracts and reviews. To him, therefore, the publication of the 'International Catalogue,' unsatisfactory as it is in many respects, means the relief from cataloguing to which reference has just been made, and this means the addition of just so many more hours to constructive work.

The chief complaint which is to be made regarding the first volume on meteorology (1901) of the 'International Catalogue' is the entire omission of the *Meteorologische Zeitschrift*. The *Zeitschrift* is by far the most important of all meteorological journals, and no one can pretend to keep up with the progress of the science who does not see this publication regularly. It is evident, moreover, that Austrian publications as a whole were neglected, for we miss also the *Sitzungsberichte* and the *Denkschriften der Wiener Akademie der Wissenschaften,* which have always contained valuable contributions to meteorology. Furthermore, Dr. Hann, whose writings on meteorology are among the most important the world over, and who by common consent stands in the very front rank of meteorologists and climatologists, appears in this volume only as the author of the 'Lehrbuch der Meteorologie' and of one article, of comparatively little note, published in the *Geographische Zeitschrift.* It is almost inconceivable that this volume should have been allowed to appear without any mention of the *Zeitschrift* and of the Vienna Academy publications. Doubtless the mistake will be rectified in the 1902 issue, and it certainly should be.

There are a number of misprints. Among them we have noted the spelling of Dr. Köppen's name as Koppen; of *Meteorologie* as *Meterologie,* etc. Nevertheless, with all its imperfections—and we do not propose to debate here the question of the classification which has been adopted by the International Council—the 1901 volume on meteorology of the catalogue will be received by many workers in meteorology, as it has been by the writer, with a grateful feeling of relief.

While considering meteorological bibliographies, it is to be hoped that an appropriation from the Carnegie fund may be made with a view to completing and printing the 'Signal Service Bibliography' above alluded to. The few copies of that publication which were sent out, in the very crude form which was alone possible at the time of its issue, but emphasized the importance of the work. It would be a very great help to meteorologists and other persons who have need to refer to meteorological literature, if the 'Signal Service Bibliography' could at last be completed and properly printed.

As regards current meteorological bibliographies, these are now published regularly in three journals, the *Meteorologische Zeitschrift,* the *Monthly Weather Review* and the *Quarterly Journal of the Royal Meteorological Society.* With these lists coming in from month to month, and with the annual list in the 'International Catalogue,' the lot of working meteorologists and climatologists, as well as of teachers and students of these branches of science, is made much easier than it was a year or so ago.

R. DEC. WARD.

BOTANICAL NOTES.

ANOTHER FERN BOOK.

UNDER the simple title of 'Ferns' Dr. C. E. Waters, of Baltimore, has added another book of 362 large octavo pages to the quite creditable list of popular treatises on the ferns of the northeastern United States, and it has been given fitting form by the publishers, Holt and Company, of New York City. The work is intended for amateurs, and is in fact a popular manual based on analytical keys which can be used for the identification of ferns whether fruiting or not. This is accomplished by having, in addition to the usual key based on the fructification, another which makes use of characters derived from the stalks alone. In this the number and shape of the fibro-vascular bundles are of primary importance, but to these are added other characters, as the size, color, ridges, grooves, etc., of the surface of the stalks. For the bundle characters good diagrams are used, and throughout the work there are about two hundred admirable 'half-tone' reproductions of photographs, which must prove very helpful to the student, whether amateur or professional. The keys refer to fuller descriptions of each species, and these are all that one could wish in a book of this kind. There is first a short, somewhat technical description (in smaller type), and this is followed by a popular account which runs on with a charming freedom from conventionality. There is no attempt to treat every species in the same manner; on the contrary, the author seems purposely to have varied his treatment, often making an apt quotation of a stanza or two from some poem.

The nomenclature is nearly that of a decade or two ago, but modern synonyms are given sufficiently to make the book usable by those who have access only to very recent manuals. It is of little moment in a book of this kind what nomenclature is used, and for this reason the omission of the authority for the species is of no consequence. It is sufficient to say that the author knows ferns so well that his pronouncement may well be accepted by all amateur students of the ferns. The book should have a wide circulation among the large number of people who love ferns and want to know something about them. It will also be found to be a very useful book in the library of the professional botanist.

ST. LOUIS AND THE BOTANISTS.

IN a few weeks the botanists of the country will have the opportunity of visiting St. Louis in order to attend the meetings of the botanical section (G) of the American Association for the Advancement of Science, and the affiliated societies. The botanical attractions are unusually great in St. Louis. The Missouri Botanical Garden, with its wealth of living plants in the extensive hothouses, and the out-of-door plantations covering many acres of ground, will interest every botanist who visits it. Then there is the garden herbarium, one of the largest in America, and very rich in type specimens, and also the collections of botanical works constituting the large garden library. Here are the specimens and books which Dr. George Engelmann studied and used, and here are the rooms and buildings in which he worked. To the younger generation of botanists these associations should be unusually attractive, for it is helpful to see where and with what means those who preceded us have done their work. There should be a full attendance of botanists at these meetings.

THE ECONOMIC PLANTS OF PORTO RICO.

SEVERAL years ago O. F. Cook and G. N. Collins were sent by the United States Department of Agriculture to Porto Rico to make investigations in regard to the agriculture of the island. One result of their work has been the preparation of a thick pamphlet of somewhat more than two hundred octavo pages consisting of an annotated list of Porto Rican plants of economic importance. It appears as one of the 'Contributions from the United States National Herbarium' (Vol. VIII., part 2), under the supervision of the curator of botany, Mr. F. V. Coville.

In the short introduction reference is made to the books on the plants of the island, in which the authors say that "the botany of Porto Rico is far from complete, and very

little of it has been written in the English language. * * * But two authors have attempted a connected sketch of the Porto Rican flora, and the efforts of these not only remain incomplete in that they do not cover the entire series of families of flowering plants, but the lists are also partial and local, as the writers themselves realized. The first of these sketches was that of Don Domingo Bello y Espinosa ('Apuntes para la flora de Puerto-Rico,' 1881–1883). * * * The second of these sketches and the most important contribution to the botany of Porto Rico is the Flora projected by Dr. A. Stahl, of Bayamon, but unfortunately only partially published ('Estudios para la flora de Puerto-Rico,' 1884–1888). * * * In spite of public indifference and official animosity six parts of the flora were issued at the expense of the author, having been prepared in the intervals of his professional life as a physician. Publication ceased in 1888, and Dr. Stahl no longer hopes to continue the work." Two other titles are given, viz., 'Diccionario botanico de los nombres vulgares cubanos y Puerto-Riquenos,' by Manuel Gomez de la Maza, and 'El medico botanico criollo,' by Rene de Grosourdy.

The catalogue proper consists of an alphabetical list of names, common and scientific, with descriptive notes and cross references. Here the reader finds many interesting facts about tropical and semitropical plants which are or might be grown in Porto Rico and other West Indian islands. One is struck, after reading a few pages, with the fact that there is much to be done on this island possession of ours in order to develop its use of the plants which may be grown there with profit. Coffee appears to be the most important of the cultivated plants, and yet we learn that "the most careless and wasteful methods are practised in the culture of this important crop. No attention is paid to the selection of seedlings, most of the new plants being secured from seeds that have germinated under the trees in the old plantations. It is estimated that by proper methods of cultivation the yield from the land now devoted to coffee could be doubled or tripled." Similar statements are made with reference to most of the crops of the island. Evidently there is a field of work here for the United States Department of Agriculture, and this volume is an indication that it is entering upon it with energy and ability.

CHARLES E. BESSEY.
THE UNIVERSITY OF NEBRASKA.

THE CARNEGIE INSTITUTION.

THE newspaper reports in regard to the second annual meeting of the trustees of the Carnegie Institution, held in Washington on December 9, read as follows:

"There were two sessions, with a dinner following. The report submitted on the proceedings of the last year was supplemented by explanatory statements by Dr. Gilman, the president of the institution, and by Dr. Walcott, the secretary. The report on the year's operations showed sixty-six grants made by the executive committee for scientific research, involving an aggregate of $150,000, and recipients representing every part of the United States and the smaller colleges as well as the large universities, observatories and laboratories. Twenty-five research assistants were appointed. These sums are exclusive of administrative and incidental expenses of the institution. The beneficiaries are given the option of making public the nature of these grants. Action on request for 1,022 grants, involving an allowance of $3,000,000 a year, was indefinitely postponed. Arrangements have been made for publication at an early day of eleven scientific papers, most of them making large and costly volumes. Among the subjects now under consideration by the institution in connection with grants are a solar observatory; southern observatory; geophysical laboratory; Transcaspian exploration and archeological exploration; exploration in the south Pacific, establishment of biological experiment laboratories and international magnetic researches.

"The morning session was devoted mostly to a discussion of several large projects. No conclusion was announced. The trustees authorized an aggregate expenditure of $373,000 in grants for scientific researches and $40,000 for publications during the ensuing year.

"It is said that Mr. Carnegie made a brief address, in which he commended the work already done and talked of the aim of the institution to give liberal encouragement, in cooperation with other institutions, to investigation, research and discovery; to provide buildings, laboratories,

books and apparatus and afford advanced instruction to qualified students.

"The following officers of the Board of Trustees were elected:

Chairman—John S. Billings, New York; Vice-Chairman—Elihu Root, secretary of war; Secretary—Charles D. Walcott, director of the geological survey.

Vacancies on the board were filled by the election of John Cadwalader of New York to succeed Abram S. Hewitt, deceased; Cleveland E. Dodge, New York, to succeed William E. Dodge, deceased, and Judge William Wirt Howe, New Orleans, to succeed Justice Edward D. White, resigned.

Secretary of State John Hay was chosen as a member of the executive committee in the class of 1905 to succeed Mr. Hewitt and Dr. S. Weir Mitchell and Carroll D. Wright were reelected for three years as members of the executive committee.

"President D. C. Gilman will resign his office one year hence. For some time rumors have been current that Dr. Gilman would retire during the present meeting, and when it was known that he and Mr. Carnegie had had a long private conference it was assumed that the matter was settled. A letter from Dr. Gilman to the trustees, however, showed that he did not intend to make any sudden move. His letter reminded his colleagues that the fixed term of the presidency of the institution was five years, of which he had now served two; that his increasing age made the labors of an executive at the head of so great an establishment very onerous, and that he did not feel that he could continue to bear the burdens beyond the next year, when he should expect the acceptance of his resignation."

HENRY CARRINGTON BOLTON.

At a meeting called by the Washington Chemical Society, held in Columbian University, on Monday evening, November 25, in honor of the memory of the late Henry Carrington Bolton, addresses were made by the president of the society, Dr. F. K. Cameron, Dr. Chas. E. Munroe, Dr. H. W. Wiley, Dr. F. W. Clarke, Dr. Marcus Benjamin and Professor R. B. Warder. A committee consisting of Drs. Munroe, Clarke and Wiley was appointed with power to formally express the sorrow of the members of the society for the bereavement which they had suffered. Following is the memorial prepared by the committee:

"Death has suddenly removed from earth our friend and coworker, Dr. Henry Carrington Bolton. In his death chemistry has lost a disciple, who gave to her service the enthusiasm of his youth, the strength of his manhood and the wise council of his riper years.

"Our section has lost a member who through his experimental researches and especially by his notable additions to bibliography has contributed much to the advancement of the science which it is the purpose of this society to promote. These distinguished services to science have placed all who are interested in chemistry under lasting obligations.

"The student of chemistry has lost a friend who was always ready to extend the right hand of fellowship and to contribute freely from his rare store of knowledge and extended experience.

"The community has lost a man who by his genial qualities, his high ideals, his faithfulness to the duties he undertook, his catholicity of views and of interests and his tolerance of the opinions of others endeared him to all who knew him.

"His life was a benefaction, his presence always a blessing and his career one of usefulness to man.

"We ask that this tribute to his memory be spread upon the minutes of the society; that it be printed in the proceedings and in Science and that an engrossed copy be presented to Mrs. Bolton.

"On behalf of the society,

"Chas. E. Munroe,
"F. W. Clarke,
"H. W. Wiley."

SCIENTIFIC NOTES AND NEWS.

The Royal Society held its anniversary meeting on November 30, when the officers were elected whose names have already been printed in this journal. A contest took place for the post of general secretary, vacant by the resignation of Sir Michael Foster, for which Sir Archibald Geikie was nominated by

the council and Professor W. D. Halliburton by a considerable number of independent fellows, and the former was elected by a large majority. The president, Sir William Huggins, gave the usual address reviewing the activities of the society during the past year. At the banquet in the evening addresses were made by the president, Lord Robertson, Professor Curie, Lord Alverstone, Sir Arthur Rücker, Sir Michael Foster and Sir Archibald Geikie.

PROFESSOR KUNO FISCHER, now in his eightieth year, has retired from active duty as professor of philosophy in the University of Heidelberg.

PROFESSOR H. E. GREGORY, of Yale University, has begun work on a geological map of Connecticut, as provided for in a recent act of the state legislature.

PROFESSOR W. B. SCOTT, of Princeton University, lectured before the Teachers' Institute of Cooper Union on Tuesday evening, December 8, the subject being 'The Topography of Sedimentary Rocks.'

PROFESSOR SEELEY'S course of eight lectures on 'The Fossil Reptiles of South Africa' is now being given in the Geological Laboratory, King's College, on alternate Tuesdays at 4:30 P.M.

A NEW division, that of Forest Products, has been organized in the Bureau of Forestry with Dr. H. von Schrenck in charge.

MR. J. MORGAN CLEMENTS has resigned his position at the University of Wisconsin and the U. S. Geological Survey to engage in professional work in New York City.

A PRESENTATION and banquet were given on November 21 to Dr. Cunningham by his Dublin colleagues and friends, to mark their regret for his departure to Edinburgh and their appreciation of his work while professor of anatomy in Dublin University. His successor, Professor A. F. Dixon, presided.

THE American Scenic and Historic Preservation Society held, on December 9, a meeting in memory of the late Andrew H. Green at the American Museum of Natural History.

THE widow of the late Professor Virchow has given about 7,000 volumes from his library to the Berlin Medical Society.

As a matter of record, we note the death of Mr. Herbert Spencer, in his eighty-fourth year, which occurred at Brighton on December 8.

SIR FREDERICK BRAMWELL, the eminent engineer, died in London on November 30, at the age of eighty-five years. He was elected a fellow of the Royal Society in 1873; president of the Institution of Mechanical Engineers in 1874; president of the Institution of Civil Engineers in 1884, and president of the British Association for the Advancement of Science in 1888.

FOR the accommodation of delegates and members of the American Association for the Advancement of Science from New York, Philadelphia, Baltimore, Washington and cities tributary thereto to the meetings to be held in St. Louis from December 26 to January 2, the Baltimore and Ohio Railroad will run a special train composed of Pullman sleepers and dining car, leaving New York at 10:30 A.M., Philadelphia 12:48, Baltimore 3:00 and Washington 4:15 P.M., December 26, arriving at St. Louis at 5:25 P.M., December 27. For full information and seat reservations apply to Lyman McCarty, assistant general passenger agent, Baltimore and Ohio Railroad, 434 Broadway, New York, N. Y.

THE Geographical Society of Philadelphia has in press and will shortly issue Commander Peary's report on arctic explorations conducted under the auspices of the Peary Arctic Club of New York, and covering a period of five years. At the meeting of the society on December 2, an address was delivered by Dr. Frederick A. Cook, of Brooklyn, on his recent researches in the McKinley range of Alaska and the attempted, but not successful, ascent of the loftiest summit of the North American continent. The official report of these researches will also be published by the Philadelphia Society.

THE executive board of the Association for maintaining the American women's table at the Zoological Station at Naples and for promoting scientific research by women an-

nounces that applications for the Naples table for the year 1904 should be sent to the secretary, Miss Cornelia M. Clapp, Mount Holyoke College, South Hadley, Mass. During the past five years eight women have been appointed by the association, seven of whom have received the title of 'scholar.' Through the special kindness of Dr. Dohrn, two may be received at the station at the same time, both having placed at their disposal equal opportunities for work.

The New York Aquarium will hereafter use for its salt-water tank the closed circulation system, the water being brought from the sea and kept in a reservoir of 100,000 gallons. After the water is used it is filtered and aerated and returned to the reservoir. Hitherto the water has been taken from the bay, where it varies in density and purity.

Transit-room shutters of a new design by Professor D. P. Todd were erected the last week in November at Amherst College Observatory. They were built by the Coburn Trolley Track Company and the Norton Iron Works, with special reference to ease and rapidity of working.

UNIVERSITY AND EDUCATIONAL NEWS.

By the will of William Wyman, of Baltimore, the Johns Hopkins University may expect ultimately to receive the residue of his estate, valued at $500,000.

By the will of Henry S. Nourse, of Lancaster, Mass., a fund is set aside for Harvard University which will amount to at least $50,000.

Columbia University has received a gift of $5,000 from Mrs. Butler, of New York, to found a scholarship; an anonymous gift of $10,000 is also announced.

It appears that the will of the late Gordon McKay, leaving a very large sum for scientific work at Harvard University, will be contested by a distant relative.

The University of Aberdeen has received from the trustees of the late Mr. John Reid, of Shannaburn, a sum that will provide not less than $2,000 a year for post-graduate research scholarships.

The University of Wales has received by the will of the late Mr. Price Davies, of Leeds, the sum of about $35,000 for scholarships.

Sir William MacDonald has given $2,000 to McGill University for experimental work in physics.

A school in biology will be conducted at Coronado Beach during the Christmas vacation, under the auspices of the University of California. The work will be directed by Professors W. E. Ritter and C. A. Kofoid.

Principal Peterson, of McGill University, after a conference with Sir Thomas Shaughnessy, president of the Canadian Pacific Railway, has announced that a railway department will be created in connection with the university.

At an educational meeting held at the University of Chicago on November 15 and attended by more than two hundred superintendents of high schools and academies of the middle west, it was unanimously resolved that the first two years of college work should be added to the curriculum of high schools and academies.

It is reported that Dr. Charles W. Dabney, president of the University of Tennessee, has been offered the presidency of the University of Cincinnati.

Dr. Thomas Hunt Morgan, now professor of biology at Bryn Mawr College, has been elected professor of experimental zoology in Columbia University.

Professor Hugo Münsterberg, of Harvard University, has been elected non-resident lecturer on psychology at Columbia University, where he will give a special course of lectures in the early spring.

Professor F. G. Wrenn has been elected Walker Professor of Mathematics in Tufts College in the room of the late Benjamin F. Brown.

Mr. T. H. Havelock, fifteenth wrangler in 1900, Smith's prizeman in 1901 and Isaac Newton student in 1902, has been elected fellow of St. John's College, Cambridge.